

Application of Airbag Technology for Vehicle Protection

Richard Fong, William Ng, Peter Rottinger and Steve Tang*
U.S. ARMY ARDEC
Picatinny, NJ 07806

ABSTRACT

The Warheads Group at the U.S. Army ARDEC developed a novel non-energetic RPG protection munition based on automotive airbag technology. This munition dispenses an airbag to impact an RPG causing it to go high order at long standoff causing the shaped charge jet to be ineffective. There are many advantages for this munition, primarily there are no explosions and no high energy fragments dispersed, therefore, no fratricide issues. Dynamic testing has demonstrated that this technology is capable of meeting these requirements.

1. BACKGROUND

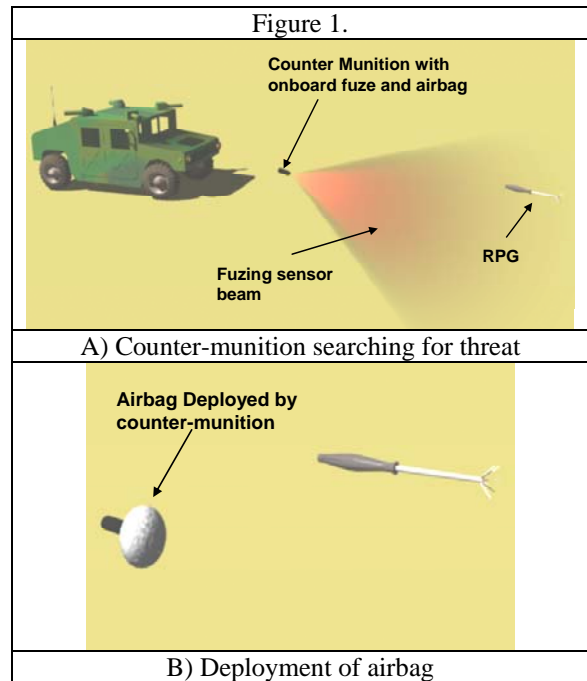
The RPG is the weapon of choice because their availability, ease of deployment and low cost. These factors make them widely proliferated and suitable for ambush attacks. While the RPG has little impact on heavily armored vehicles because thick armor stops the shaped charge jet penetration, they pose significant threats to lightly armored vehicles such as Stryker, HUMMWV, and other combat vehicles. For this reason, the U.S. Army is pursuing an Active Protection System to provide vehicle survivability against this threat.

Both government and industry are investigating several Active Protection System (APS) initiatives. The vast majority of Active Protection Systems are energetic in nature, deploying a fragmenting explosive warhead or high velocity / high energy projectile. While these energetic solutions are effective against the RPG threat, they can pose problems when used in heavily populated, urban environments.

In view of the above, the Warheads Group at the U.S. Army ARDEC developed a novel non-energetic RPG protection munition based on automotive airbag technology. Figure 1 depicts the operation of this munition. The figure shows the munition being launched to intercept the incoming RPG. Upon launch, the munition dispenses an airbag to either deflect the RPG away from the vehicle or crash into the RPG causing it to pre-detonate at a large standoff from the vehicle, rendering it ineffective.

While there are many advantages for this munition, first and foremost, is that there are no explosions and no high energy fragments dispersed, therefore, no fratricide

issues. Because this munition contains no energetic material, it can be fielded quickly as a first generation Active Protection System that can offer a high level of protection for U.S. troops.



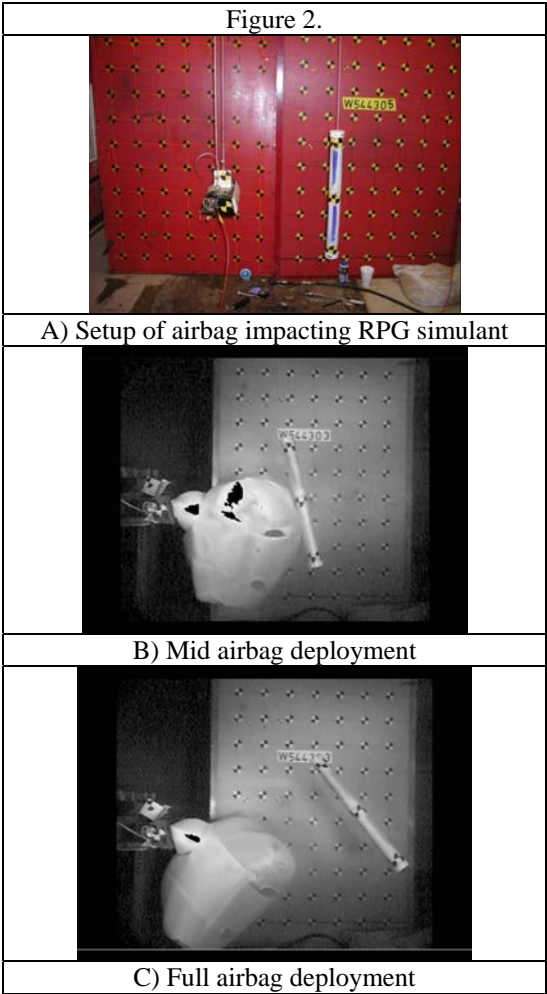
2. INTRODUCTION

Initially, the idea behind the concept was to deflect an incoming RPG away from a vehicle. A series of experiments were conducted using an airbag to characterize this deflection. The purposes are 1) to characterize the airbag deployment, 2) measure the amount and rate of deflection, and 3) provide data to calibrate the computer model for analyzing the deflection. These initial experiments were conducted at the TRW commercial automotive airbag test facility.

A length and mass matched object was created to simulate the RPG-7. A 1995 Ford Taurus passenger side airbag was chosen for this test because it has a very high deployment-force and speed. Figure 2a shows the experiment setup. Both the airbag and RPG simulant are freely suspended. Figure 2b shows the airbag in mid deployment beginning to impact the simulant. Figure 2c shows the simulant being deflected upward. In fact, the simulant was deflected all the way up to the stop which is

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 01 NOV 2006		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Application of Airbag Technology for Vehicle Protection				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. ARMY ARDEC Picatinny, NJ 07806				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES See also ADM002075., The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 4	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

90 degrees from the start position. Table 1 summarizes this test series.



As the table shows, the experiments demonstrated the airbag’s ability to deflect a statically suspended RPG, in this case, an RPG simulant. The next experiment, conducted at ARDEC, would determine whether the airbag has the capability of deflecting an RPG in flight. Figure 3 shows the experiment setup.

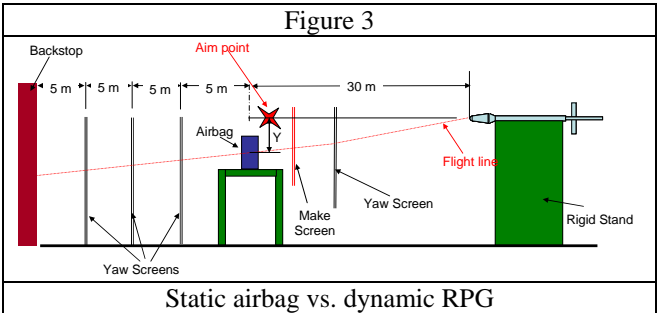
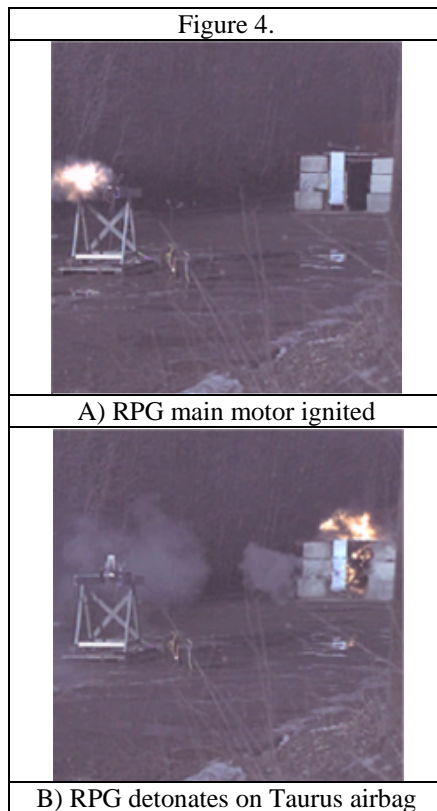


Table 1.		
Test Configuration	Test Objective	Test Result
Airbag only	Bag deployment characterization	Determined bag deployment time and size
Hard mounted airbag vs. simulant @ 0” standoff	Measure amount of simulant deflection	Simulant deflected more than 90 degrees
Hard mounted airbag vs. simulant @ 18” standoff	Measure amount of simulant deflection	Simulant deflected more than 90 degrees
Suspended airbag vs. simulant @ 0” standoff	Measure amount of simulant deflection	Simulant deflected more than 90 degrees
Suspended airbag vs. simulant @ 18” standoff	Measure amount of simulant deflection	Simulant deflected more than 90 degrees

In this experiment the airbag, a 1995 Ford Taurus passenger side airbag, is mounted to a rigid stand to intercept the dynamically fired RPG. The RPG is located 34 meters from the airbag. This distance was chosen to maximize the probability of intercept. A witness plate was placed 20 meters from the airbag to collect post intercept data. The test involves launching the RPG towards the witness plate. When the RPG passes through a make screen, it triggers the airbag to deploy deflecting the RPG as it passes the side of the bag.

After three attempts, it was apparent that, due to the uncertainty of the RPG fly out, it would be extremely difficult to time the bag deployment to strike the RPG as it flew by. The experiment was modified to have the bag partially deployed as the RPG flew by. This ensured would be some interaction of the airbag with the RPG.

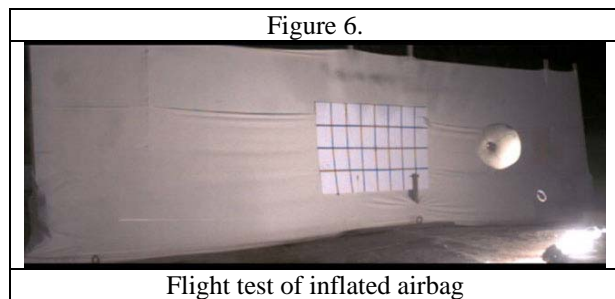
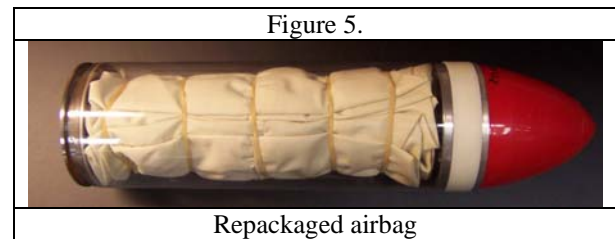
Figure 4a shows the RPG being launched towards the witness plate. Please note that the witness plate is inside the structure shown at the right side of the picture. Figure 4b shows the RPG detonating where the airbag was deployed. It turned out that the crush fuze of the RPG requires little force to generate the voltage required to detonate the warhead. When the RPG detonated, the shaped charge jet becomes ineffective because of the long standoff before impacting the witness plate. Due to the standoff only a splattering of the shaped charge jet particles was seen. This significantly reduced the effectiveness of the jet enough to protect a vehicle at that distance.



3. TACTICAL MUNITION

The tactical interceptor now contains a HUMMWV driver side airbag assembly plus inflator. This bag was chosen because 1) it can be packaged into a four inch round, and 2) it opens radially into a spherical shape, an important feature for aerodynamic stability in flight. The steel inflator doubles as the interceptor's structural member helping to drive the fully inflated bag forward in flight and maintaining course. A plastic shell houses the airbag assembly and provides an aerodynamic profile for the interceptor. When the airbag deploys, it will fracture the shell and scatter the pieces. A nose cone assembly is attached that contains the electronic timing circuit that initiates the bag inflator after time out.

Upon launch, the timing circuit starts the time out sequence. When the preset time is reached, the circuit sends an electric current to ignite the propellant in the inflator. Once ignited, the burning propellant produces enough pressure to force the pressurized inert gas to rupture the containment disk. This allows the pressurized inert gases to escape through the exhaust and inflate the airbag. Figure 5 shows the actual airbag interceptor, and Figure 6 shows the airbag deployed and in flight. In case the airbag does not deploy in flight, the nose cone is designed to come off of the interceptor so that the round can be recovered safely.



The tests show that one tactical interceptor flew with the airbag fully deployed over long distances in a relatively straight line. This is important because the interceptor can be counted on to fly and remain stable to the intercept location with the incoming threat.

4. DEMONSTRATION

Parallel to the development of the interceptor, a series of static airbag versus dynamically launched RPG tests were conducted. The objective of this test series is to determine if the HUMMWV driver side airbag would be able to defeat the RPG like the Taurus airbag did. This test series was conducted at Aberdeen Test Center (ATC).

The next series of tests would verify the effectiveness in a dynamic / dynamic environment. Figure 7 shows the setup of this test. The picture at top right shows the RPG launcher, while the picture at top left shows the air gun used to launch the airbag interceptor. When the RPG is launched, it flies through a break-screen to trigger the launch of the airbag interceptor.

Figure 8 shows the result of one of these tests. A still from the high speed video shows the alignment of the RPG to the airbag just prior to impact. Figure 8b shows that the RPG clearly detonated on the airbag. The shaped charge jet can be seen to the left of the airbag.

4. SUMMARY

Experiments clearly show the potential of automotive airbag technology as a defense against RPG attacks, either

by deflecting the RPG away from its flight path or pre-functioning the RPG far from the protection zone. They also showed it is possible to package an airbag into an interceptor that will fly straight even with the airbag deployed. Further, these experiments demonstrate the potential of the airbag interceptor as a viable means of protecting our soldiers against RPG attacks while minimizing collateral damage.

Figure 7.

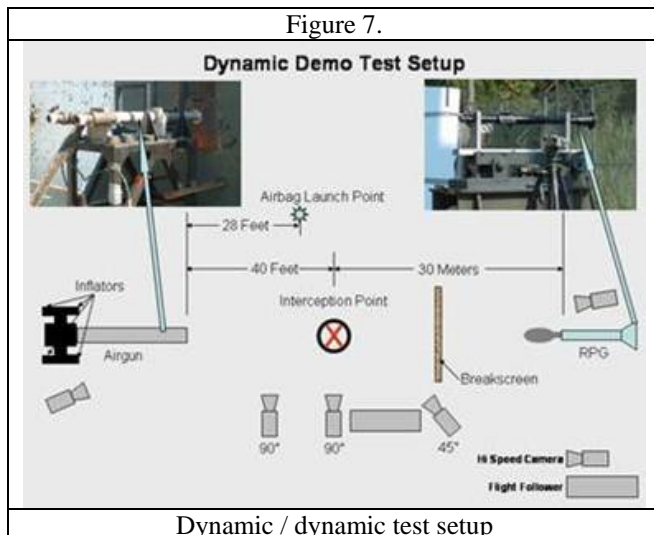
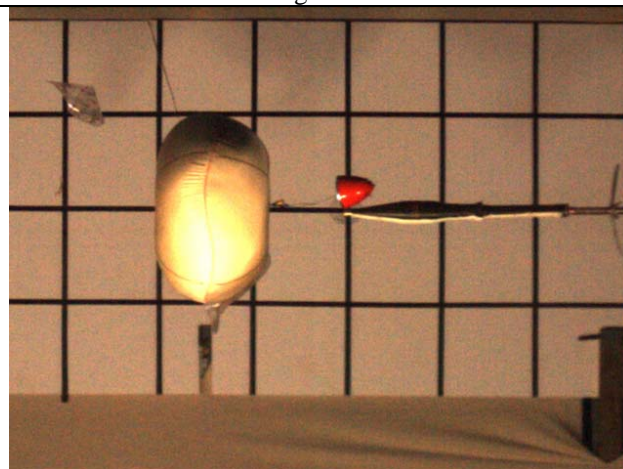
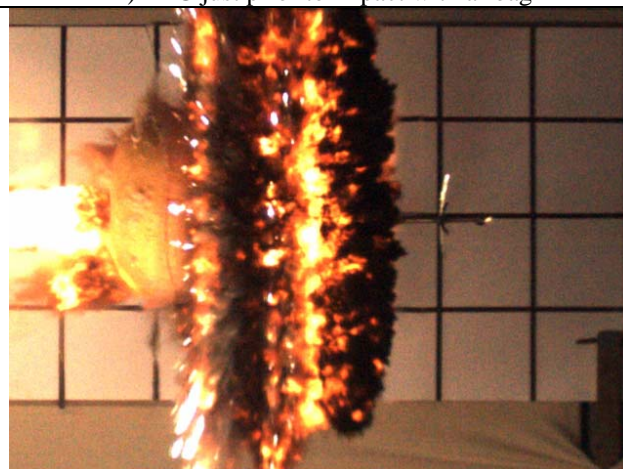


Figure 8.



A) RPG just prior to impact with airbag



B) RPG detonates on impact with airbag